

one foot, a result which will be allowed to be very strongly confirmatory of our previous deductions."

In 1844 we have a paper communicated to the Royal Society on "Changes of Temperature produced by the Rarefaction and Condensation of Air." This paper was not accepted by the Royal Society for its *Transactions*, and the *Philosophical Magazine* had the honour of publishing it! In 1845, in a paper read before the British Association, he describes experiments made by stirring water with a "sort of paddle-wheel" in a "can of peculiar construction;" and in 1846 this was followed by an important paper on "Heat disengaged in Chemical Combinations."

It was, however, in 1849 that his celebrated paper "On the Mechanical Equivalent of Heat" was communicated by Faraday to the Royal Society. This was the first of Joule's papers which was communicated to and *not* rejected by the Royal Society, and it was rewarded by a Royal Medal! In this paper he describes experiments (1) on friction of water; (2) (3) friction of mercury, two series of experiments; (4) (5) friction of cast-iron, two series. From all these he concludes:—

"(1) *That the quantity of heat produced by the friction of bodies, whether solid or liquid, is always proportional to the quantity of force expended; and*

"(2) *That the quantity of heat capable of increasing the temperature of a pound of water [weighed in vacuo and taken at between 55° and 60°] by 1° F. requires for its evolution the expenditure of a mechanical force represented by the fall of 772 lbs. through the space of one foot.'*

In 1867 a report was communicated to the British Association through the Committee on Standards of Electrical Resistance, containing the results of fresh experiments on the dynamical equivalent of heat. Finally, at the desire of this Committee, and aided by funds placed at his disposal by the British Association, Mr. Joule undertook a complete redetermination. This was commenced in 1870, and his report was given in 1878. Here is his conclusion, stated in the last two sentences of the present volume:—

"The equivalent at the sea-level and the latitude of Greenwich will therefore be 773.492 foot-pounds, defining the unit of heat to be that which a pound of water, weighed by brass weights when the barometer stands at 30 inches receives in passing from 60° to 61° F. With water weighed *in vacuo* the equivalent is finally reduced to 772.55."

It is impossible for us to do more here than mention some of the other papers contained in this volume. Perhaps among those which are of highest importance we should refer first to a short paper "On the Theoretical Velocity of Sound," in which outstanding difficulties are cleared up, and deductions as to the true relation between the specific heat of air, volume constant, and the specific heat, pressure constant, are brought forward. We have also important experiments on "Some Amalgams," in which their mode of production and characteristics are dealt with. A paper "On Surface Condensation of Steam" was largely conducive to the great improvement which the substitution of this method, for condensation by injection, has realised in the condensing engine of the present day.

In connection with his very earliest work Joule gave special attention to the construction of thermometers. He was the first to produce accurate thermometers in

England, as Regnault did, just about the same time, in France. Joule's thermometers were made for him by Mr. Dancer of Manchester. In 1867 we have a paper "On the Alteration of the Freezing-Point," giving the results of the observations of five-and-twenty years on this curious phenomenon. In the present volume the paper is supplemented by observations carried down to December 1882.

We mention, lastly, his papers describing experiments to test the brittleness supposed to be imparted to iron castings by frost—experiments which, so far as they go, negative altogether the popular idea on the subject; and with this mention we must take our leave of the volume, expressing once more our deep appreciation of its value, and earnestly hoping for the speedy appearance of its promised companion.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Long or Short Fractions for Great Natural and National Standards—Earth's Axis of Rotation

IN the two last numbers of the *American School of Mines Quarterly Journal* the learned President Barnard of Columbia College, New York, has involuntarily opened a question of far wider interest than the particular one with which he set out. For on his page 120 there stands the following remarkable statement:—

"The length of the polar axis of the earth is a quantity which may with strict truth be pronounced to be, up to this time, absolutely unknown."

Now if that really be so, the peoples of every civilised country on the face of the earth, who have been taxed during the last hundred years to the extent of millions and millions for the support of magnificent arc-of-the-meridian measuring establishments, have some right in common sense to rise with revolutionary wrath, and demand how those enormous sums of their money, given to determine the size and shape of the earth, have been expended. And when shall we know the far greater distance of the sun!

But the statement can only be true on some private interpretation which is needless to inquire into; for when we take the various lengths of the earth's axis of rotation as determined in modern times, and collected by President Barnard himself from very diverse sources indeed, we find them all to be coincident to four places of figures at least. And considering that for some other most important natural standards the world is apparently content with a certainty of two places of figures only, the officers of the several trigonometrical establishments of all the countries of Christendom deserve high praise, rather than blame, for the results they have succeeded in bringing out.

The mean of their last five measurements, as given by President Barnard for the polar axis of the earth, is

500,492,732.8 British inches,

the ten-millionth part of which is evidently

50.04927328 British inches;

though *he* has chosen to bring it out as a very different quantity indeed, viz. 49.273 British inches.

But the rather important point now to be discussed is, whether in practical use as a standard of measure, either on paper or for mechanical work, we should attempt to realise that long fraction; or be content with the

50.05 British inches,

at which, as quoted by the President, I had years ago ventured to assume the said ten-millionth of the earth's axis of rotation.

In place of merely, and perhaps vainly, *theorising* on the sub-

ject, let us look to the growth of modern opinion on a much older question, but connected with the same axis of rotation, viz. the number of solar days in a tropical year; reckoned now to be $365^{\circ}2422414 \pm x$, but assumed in the old Julian year = $365^{\circ}25$.

Pope Gregory's reformation of the calendar, by introducing the former (or something like it) in place of the latter quantity, caused sufficient disturbance to all the ordinary affairs of men in every nation when it was first adopted; and has some arguments which may be alleged in its favour still.

But if I read aright a recent tract by so consummate a physical astronomer as Prof. Simon Newcomb, he holds that the Gregorian alteration has done so much more harm than good, being quite a needless refinement, and is so totally unsuitable to calculations in physical astronomy, compared with the Julian year, that civilised nations should, and presently will, return to that year and reckoning, or "Old Style,"—leaving a few curious computers, whom it may concern, to prepare tables of corrections where they are absolutely required for their own abstruse and recondite purposes.

C. PIAZZA-SMYTH

15, Royal Terrace, Edinburgh, April 26

The Ancestor of the Dipper (*Cinclus*)

IN NATURE for April 3 (vol. xxix, p. 524) the Duke of Argyll desires Mr. Romanes to prove "that the dipper once had an ancestor which began to dive in water, &c." The Duke well knows that such ancestry cannot be exhibited, but seems unaware that there are other *land* birds that are *divers* besides the dipper (*Cinclus*). I have often seen the winter wren dart or dive through a sheet of water, and remain in the damp and dripping space behind the little cascade. The water-thrushes (*Seiurus*, sp.) all wade in water, and often, seeing minute mollusca on the bottom of the stream, plunge both head and neck beneath the surface; so that, often for several seconds, a large part of the body is submerged. Now, these birds, like the winter wren, still have the plumage "pervious to water, and so are liable to be drenched and sodden"; but they have also the faculty of giving these drenched feathers such a good shaking, that flight is practicable a moment after leaving the water. Swallows, too, are often seen flying in and through spray and thin sheets of falling waters, yet with no detriment to their flight power. Certainly the water-thrushes or wagtails (*Seiurus ludovicianus*, *auricapillus*, and *novboracensis*) have taken many preliminary steps towards becoming as aquatic as the dipper (*Cinclus*), and the winter wren, and even Maryland yellow-throat, are not far behind. The Duke can scarcely derive any comfort from the dippers; Mr. Romanes can.

CHAS. C. ABBOTT

Trenton, New Jersey, U.S.A., April 18

Double-storied Houses and Concave Roofs

IN your issue of January 31 I notice a review of Mr. Im Thurn's book on the Indians of Guiana, in which attention is called to the manner in which a pile dwelling may be converted into a two-storied house, and Prof. Moseley's suggestion that the Swiss chalet did so originate is quoted, the general impression intended being apparently that this, in the majority of cases, is the origin of a double-storied dwelling. Now in that portion of the Himalayas lying south of the snowy range, to which my personal experience is confined, double-storied houses are almost universal, the lower story being used as a cattle-shed, the upper as a dwelling; at the level of the floor a platform is carried out from the building on one side at least, usually on three, or, if the house stands clear of the hillside, on all four sides. The only means of access to this platform and the upper story is by a ladder or flight of steps—it is difficult to say which it should be called—but it consists of the trunk of a tree split in half on the flat surface of which a series of notches are cut to give foothold; this is placed in a sloping position leading to the outside edge of the platform, or if, as is often the case, the platform is inclosed by boarding, through a hole in the floor. It will be seen that this is a principle of construction such as might easily have descended from a pile dwelling, and yet I cannot believe that this is the case; my reasons are: (1) there are no lakes in the Himalayas in which the habit of building on piles could have been acquired; (2) the houses are built of dry stone, strengthened at intervals by timber frames, these frames being without exception horizontal, and built into the wall in courses, such a thing as a vertical post being unknown, while had the style of

structure descended from a pile dwelling, some trace of the piles would probably have remained, and the house been built on vertical posts whose interstices were filled in with stone, &c.; (3) though two stories are the rule, it is by no means a universal rule: the temples are frequently three, and occasionally four and even five stories high, while those of the natives who are rich enough to afford it build three-storied houses, the ground-floor being used for the cattle, the intermediate one as a storeroom, and the upper one as the dwelling. On the other hand, the Kolis or Koltas, an aboriginal race who are as a rule the servants, or practically slaves, of the so-called Brahmin and Rajput landowners, generally inhabit a single-storied cabin, but where these Kolis themselves own land and cattle, they, too, have double-storied houses. The true origin of this style of building lies, I fancy, in the fact that stone or wooden slabs are practically the only available roofing material, and the preparing and collecting these, not to mention the timbers required, forms a very serious part of the labour involved in building a house, and it is consequently an advantage to make one roof cover both the cattle and their owner rather than to undertake the labour and expense involved in two separate roofs.

In this connection there is a point to which I would wish to call attention. When first entering the Himalayas I was struck by the fact that, whereas the roofs of the villagers' houses were made with a single straight slope from ridge to eaves, those of the temples were as a rule steeper near the ridge, so as to present a concave outline, and as the ends were usually ornamented with deep weather boards fringed with pendent wooden ornaments, while the corners often had what can best be described as a wooden tassels, the appearance of the whole was decidedly Chinese; as I worked higher up into the hills, towards the region of the deodar, the origin of this construction revealed itself. Where deodar is abundant the roofs of the common houses, as well as of the temples, are made of split planks the whole width of the tree, and from 6 to 8 feet long, the ridge being made water-tight by a coping cut out of a single deodar-tree shaped into a ridge above, while in the lower side a V-shaped group is cut. If the row of planks next the ridge were set at a low angle, it might be difficult to fit this coping; but when the angle of the slope is high, the fitting is easier, and besides the beam by its weight grips the planks of the opposite slopes and holds them together effectually without the need of nails, a consideration of probably far greater weight at the time when this method of construction originated than at the present time. Thus the origin of the high slope near the ridge is explained, but to carry this high slope down to the eaves would necessitate the use of an inordinate amount of material, and so the second row of planks is arranged with a gentle slope; in those rare cases where the roof is large enough to require three separate rows of planks, the middle one is arranged generally with a slope intermediate between those of the two marginal ones, and the roof assumes a concave form. As deodar gets scarce the first roofs in which it disappears are those of the villagers' houses, and it is invariably the lower or gentle slope that is the first to be roofed with stone; then this spreads on to the steeper part of the roof, but here the slope has to be lessened or the slates nailed on. Where roofing slabs can be obtained, large and well-shaped, the latter alternative is adopted, and merely the deodar coping remains of the original wooden roof; as a last stage this too disappears, and the ridge is made water-tight by carrying the slates of one slope over the edges of those of the other. This style of roof, however, only persists where roofing slabs are obtained in such abundance and of such size that they can be cut to the desired shape; where slates are only procurable of small sizes and irregular shapes, the concave roof is soon found to be inapplicable, the higher slope near the ridge disappears, and the roof assumes the form of a single gentle slope, but in the temples the archaic form survives. I have called attention to this concave outline of roof because a similar concavity of outline in Chinese roofs is commonly said to be a survival from the time when the Chinese dwelt in tents; this can hardly be the true explanation, for, as Fergusson has pointed out, the Tartar tents, and those of all nomads with which I am acquainted, have a convex and not concave outline. I do not know whether there are in China any trees from which roofing slabs of good quality are or could be made, nor have I at present means of access to any books by reference to which I could settle this question, but if such be the case it is more probable that the concave outline originated as I have indicated above than in the manner suggested by Fergusson in his book on Eastern architecture.